OPERATION/MAINTENANCE INFORMATION FOR THE

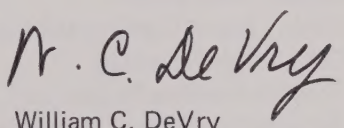
HIGH VOLTAGE POWER SUPPLY NO. 20600/20620

ENERGY CONCEPTS, INC.

INTRODUCTION

This manual provides operational and service information for the High Voltage Power Supply, part number 20600/20620. This instrument is backed by more than sixty years of experience in design and manufacturing of educational and practical training equipment. Every effort has been made to design into each unit a maximum degree of dependability, accuracy, and durability. New products are constantly being designed to meet the needs of both education and the service industries. We welcome any thoughts or comments that you may have about our products or test equipment, and will be pleased to hear from you.

We continue to look forward to serving you in the future.



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President

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WARRANTY

SCHEMATIC

SPECIFICATIONS*

HIGH VOLTAGE POWER SUPPLY PART NO. 20600/20620

OUTPUT VOLTAGE:
Regulated +5 VDC to +300 VDC loaded, continuously variable
0 to −50 VDC continuously variable
12.6 VAC, fixed
6.3 VAC, fixed

OUTPUT CURRENT:
+300 VDC: 0-100 mA current shutdown
−50 VDC: 0-2.5 mA
6.3/12.6 VAC: 2.0 amp.

LINE/LOAD REGULATION:
+300 VDC Output: 0.5%
−50 VDC Output: 1%

RIPPLE/NOISE:
Less than .1% at any voltage level

PROTECTION:
Primary: internal fuse
Secondary: (+300): current shutdown
Secondary: (−50): automatic limiting
AC Output: circuit breaker

CONTROLS:
B+: 5-300 VDC adjust
C−: 0-50 VDC adjust

SWITCHES:
Power: pushbutton, alternate action
Voltage Selector: (2) pushbuttons alternate action; 5-150 VDC and 150-300 VDC
Metering: (3) pushbuttons alternate action; 0-300 VDC 0-50 VDC and 0-100 mA

METER:
Construction: 4-inch low profile pivot and jewel movement
Movement: ±2% accuracy full scale
Scales (3), Mirrored: 0-300 (+VDC)
0-50 (−VDC)
0-100 (mA)

OUTPUT RECEPTACLES/CONNECTORS:
B+ (0-300 VDC): 5-way binding post
Common: 5-way binding post
C− (0-50 VDC): 5-way binding post
Common: 5-way binding post
6.3/12.6 VAC: two 5-way binding posts
6.3 VAC (common): 5-way binding posts

INDICATORS:
Neon Lamp (red): power "on"
LED: "flashing" overload indicator

POWER REQUIREMENTS:
Line Voltage: 105-130 VAC @ 50/60 Hz
Power Consumption: 85 watts
Power Cable: 3-wire grounding type

***SPECIFICATIONS AND DESCRIPTIONS SUBJECT TO CHANGE WITHOUT NOTICE**

OPERATING INFORMATION

SECTION 1

GENERAL

The Energy Concepts High Voltage Power Supply, No. 20600/20620, provides high DC voltage, biasing, and filament AC voltages from a single laboratory unit. The high DC voltage section has two ranges: 5-150 VDC and 150-300 VDC. The two ranges are variable continuously through the use of the Voltage Adjust Control. An independent bias supply section is provided which is variable continuously from 0 to −50 VDC. The filament supply section provides 12.6 and 6.3 VAC, which are available from the front panel at all times while the power supply is in operation.

Two voltage ranges are available by selecting one of two range pushbuttons. Voltage or current may be monitored from one of three scales on the mirror-backed output meter. The appropriate metering range is obtained through a set of pushbuttons which selects the desired scale. Output connections are made through the front panel using color-coded, 5-way binding posts.

All the function controls and receptacles needed for normal operation of the High Voltage Power Supply are located on the front panel, and are clearly identified for operation safety and convenience.

FRONT CONTROL PANEL

In the following paragraphs, a description of each control and receptacle is keyed to the encircled numbers in Figure 1-1.

1. POWER-ON INDICATOR

The Power-ON Indicator is an enclosed neon lamp which is illuminated whenever the Power Switch is closed, and proper line current is made available.

2. POWER SWITCH

117 volt, 60 Hz AC power is applied to the unit through a pushbutton switch. Power is applied to the unit when the switch is in the IN position. Power is removed from the unit when the switch is in the OUT position.

3. 0-300 VDC METERING SWITCH

The 0-300 VDC Metering Switch is depressed to monitor the voltage available at the B+ output terminals (Items 10 and 11), and which is read on the upper scale (Item 24) of the Output Meter.

4. 0-100 mA METERING SWITCH

The 0-100 mA Metering Switch is depressed to monitor the current through the B+ output terminals (Items 10 and 11), and which is read on the lower scale (Item 22) of the Output Meter.

5. 0-50 VDC METERING SWITCH

The 0-50 VDC Metering Switch is depressed to monitor the voltage available at the C− output terminals (Items 13 and 15), and which is read on the middle scale (Item 23) of the Output Meter.

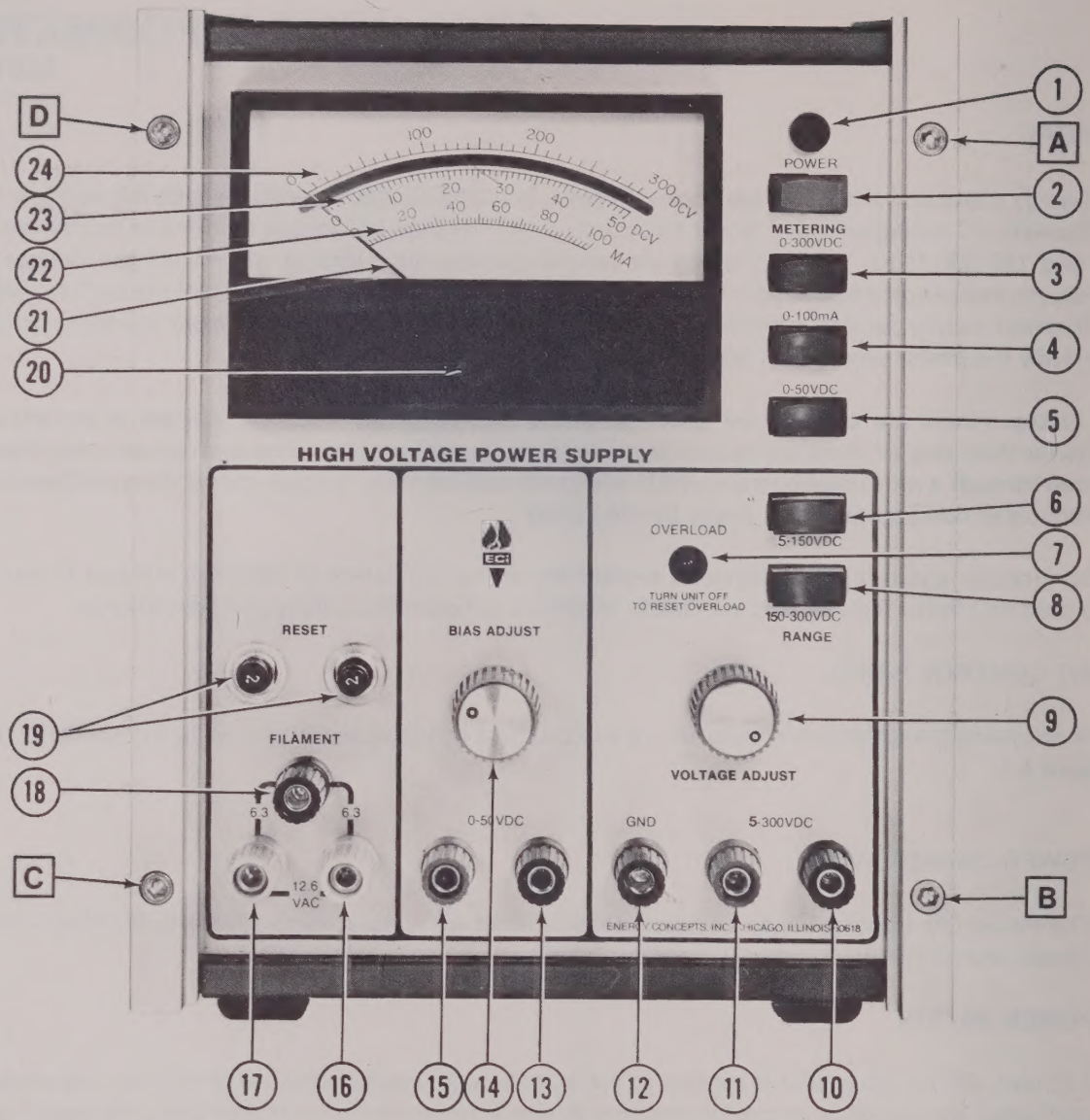

FIGURE 1-1

6. 5-150 VDC RANGE SWITCH

The 5-150 VDC Range Switch is depressed to obtain a voltage between the output jacks (Items 10 and 11). The output voltage can be varied between 5 and 150 VDC with the Voltage Adjust Control (Item 9).

7. OVERLOAD INDICATOR

The 5-300 Volt Supply is current limited at 100 mA. The Overload Indicator light flashes and the output voltage drops to zero if the output current exceeds 100 mA. The supply may be reset by turning the High Voltage Supply off for one second.

8. 150-300 VDC RANGE SWITCH

The 150-300 VDC Range Switch is depressed to obtain a voltage between the output jacks (Items 10 and 11). The output voltage can be varied between 150 and 300 VDC with the Voltage Adjust Control (Item 9).

9. VOLTAGE ADJUST

The Voltage Adjust Control is used to vary the B+ voltage over two power supply ranges. When the 5-150 VDC Range Switch is depressed (Item 6), the voltage may be varied between 5 and 150 VDC. Likewise when the 150-300 VDC Range Switch is depressed (Item 8), the voltage may be varied between 150 and 300 VDC. Then adjustments can be monitored simultaneously by depressing the 0-300 VDC Metering Switch (Item 3), and reading the voltage directly from the red 0-300 DCV scale (Item 24).

10. B+ COMMON TERMINAL

The B+ COMMON terminal is a black 5-way binding post which is connected to the common side of the power supply. The B+ output voltage is available between this terminal and the red 0-300 VDC terminal (Item 11).

11. B+ (5-300) VDC OUTPUT TERMINAL

The B+ output terminal is a red 5-way binding post which is connected to the positive side of the +300 VDC supply. The B+ output voltage is available between this terminal and the black COMMON terminal (Item 10).

NOTE

THE COMMON TERMINALS (ITEMS 10 AND 11) ARE FLOATING – OR ELECTRICALLY ISOLATED – FROM CHASSIS GROUND.

12. CHASSIS GROUND

The GROUND terminal is a green 5-way binding post which is connected to the GROUND side of the AC power line, and to the power supply chassis.

CAUTION

HIGH VOLTAGES MAY REMAIN MOMENTARILY AT THE B+ OUTPUT TERMINALS AFTER AC POWER HAS BEEN REMOVED FROM THE UNIT.

13. C– COMMON TERMINAL

The C– COMMON terminal is a black 5-way binding post which is connected to the common side of the power supply. The C– output voltage is available between this terminal and the blue 0-50 VDC terminal (Item 15).

14. BIAS ADJUST

The Bias Adjust Control is used to vary the C– output over the entire 0-50 VDC power supply range. This adjustment can be monitored simultaneously by depressing the 0-50 VDC Metering Switch (Item 5), and reading the voltage directly from the blue 0-50 DCV scale (Item 23).

15. C– (0-50) VDC OUTPUT TERMINAL

The C– output terminal is a blue 5-way binding post which is connected to the negative side of the –50 volt supply. The C– output voltage is available between this terminal and the black COMMON terminal (Item 13).

> **NOTE**
>
> THE COMMON TERMINALS (ITEMS 10 AND 13) ARE FLOATING – OR ELECTRICALLY ISOLATED – FROM CHASSIS GROUND.

16. & 17. 12.6/6.3 VAC OUTPUT TERMINALS

The 12.6/6.3 VAC output terminals are yellow 5-way binding posts which are connected to either side of the 12.6 volt filament power supply. A 12.6 AC voltage is available between these terminals.

6.3 AC voltage is available between either of the yellow terminals and the black COMMON terminal (Item 18).

18. 6.3 VAC COMMON TERMINAL

The 6.3 VAC COMMON terminal is a black 5-way binding post which is connected to the center tap of the filament transformer. A 6.3 AC voltage is available between this terminal and either of the yellow terminals (Items 16 and 17).

19. FILAMENT CIRCUIT BREAKER RESET BUTTONS

The filament circuit breakers protect the 12.6 and 6.3 VAC outputs from overloads. When a short or overload condition occurs, the breaker will trip, and the reset button will protrude an additional 3/16" from its normal position. The breakers can be reset approximately 30 seconds after the overload occurs by depressing and releasing the reset buttons.

20. METER ZERO ADJUSTMENT SCREW

The Output Meter can be zeroed mechanically by using the Meter Zero Adjustment Screw. The meter pointer can be brought to zero on the voltage and current scales by rotating the screw until the pointer rests directly above the zero mark. This adjustment should be performed only when the instrument is in a normal, upright operating position, and the unit is turned "off."

21. OUTPUT METER AND POINTER

The Output Meter can be used to monitor voltage and current at the B+ output terminals, and voltage at the C– output terminals. The proper function is selected using the metering switches (Items 3, 4, and 5). The meter pointer indicates the readings on three scales (Items 22, 23, and 24).

22. 0-100 mA SCALE

The 0-100 mA (lower) scale of the Output Meter provides direct reading of the B+ output terminals in MILLIAMPERES. The major division marks are in increments of 20 milliamperes. The smaller division marks are in increments of 2 milliamperes. (See Figure 1-2.)

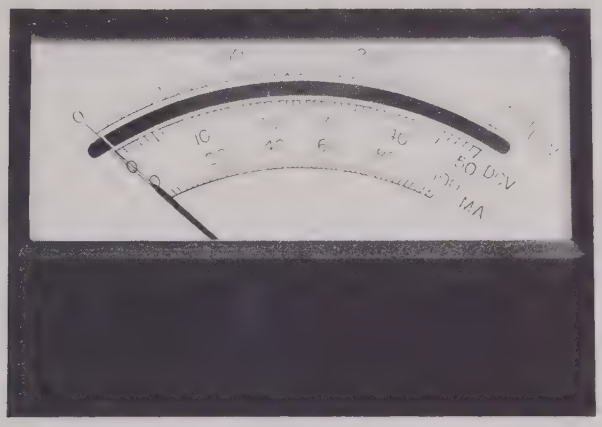

FIGURE 1-2

23. 0-50 VDC SCALE

The 0-50 VDC (middle) blue scale of the Output Meter provides direct reading of the C– output terminals in VOLTS. The major division marks are in increments of 10 volts. The smaller division marks are in increments of 1 volt. (See Figure 1-2.)

24. 0-300 VDC SCALE

The 0-300 VDC (upper) red scale of the Output Meter provides direct reading of the B+ output terminals in VOLTS. The major division marks are in increments of 100 volts. The smaller division marks are in increments of 10 volts. (See Figure 1-2.)

OPERATING PROCEDURE

GENERAL

The Energy Concepts High Voltage Power Supply is portable and can be placed on any flat, vibration-free surface for satisfactory operation. There should be free space above the power supply to ensure the flow of cooling air.

Before proceeding with the operation of the High Voltage Power Supply, it is important that the operator thoroughly understand the function of all controls, binding posts, and circuit breakers. Descriptions of these items are given in the Front Control Panel section of this manual, with references made to Figure 1-1.

The following three steps should be performed before inserting the power cable into a 117 volt, 50/60 Hz AC outlet.

1. Rotate all controls fully counterclockwise.
2. Mechanically zero the meter.
3. Be sure that there are no leads or wires from the output terminals which may be shorted to the cabinet or to each other.

TEST LEADS

Figure 1-3 illustrates acceptable methods for connecting test leads to the 5-way binding posts. Optional test leads, which can be used with this instrument, have an insulated alligator clip at one end and a banana jack at the opposite end.

Test leads should be the same color as the binding posts to minimize connection errors.

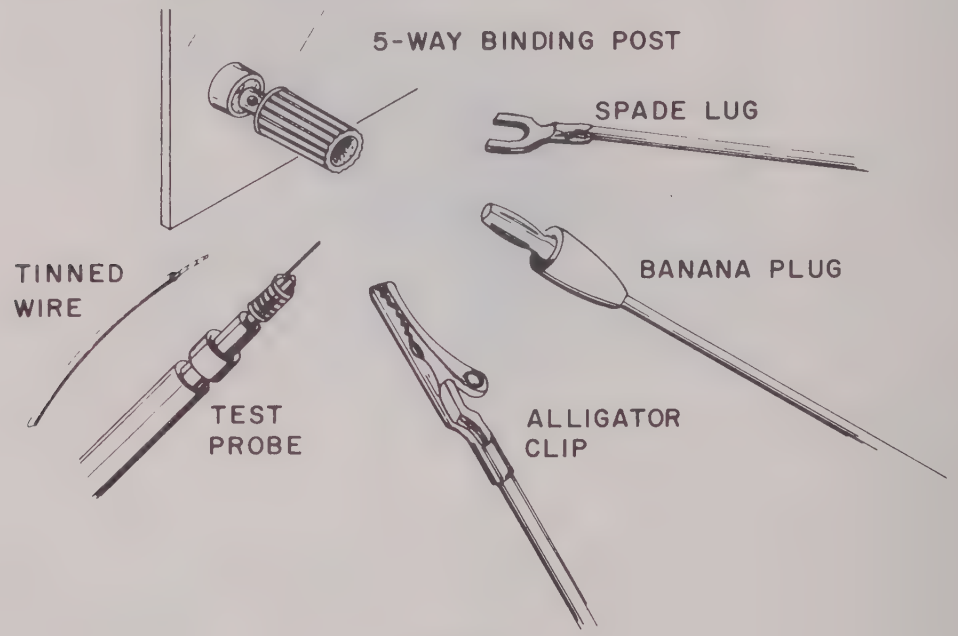

FIGURE 1-3

DC VOLTAGE (5 to +150 VDC, 150 to +300 VDC)

1. Connect the AC power cable to a 117 volt, 50/60 Hz source and activate the Power Switch to the ON position. The Power-ON Indicator will now light.

2. Position a multimeter close to the power supply and set to measure safely positive (+) DC at 300 volts.

3. Observing proper polarity, connect the multimeter to the B+ output terminals.

4. Depress the 0-300 VDC Metering Switch and the 5-150 VDC Range Switch.

> **CAUTION**
>
> THE NEXT STEP INVOLVES HIGH VOLTAGE. REMOVE ANY JEWELRY WHICH MAY ACCIDENTALLY COME IN CONTACT WITH THE OUTPUT TERMINALS.

5. Rotate the Voltage Adjust Control clockwise until 150 VDC is read on the top red 0-300 DCV scale.

6. Compare this with the multimeter reading.

7. Rotate the Voltage Adjust Control fully counterclockwise.

8. Depress the 0-300 VDC Metering Switch and rotate the Voltage Adjust Control clockwise until 300 VDC is read on the top red 0-300 DCV scale.

9. Compare this with the multimeter readings. The multimeter should read within 3% of 300 volts. (291-309 volts.)

> **NOTE**
>
> OUT-OF-TOLERANCE READINGS MAY BE DUE TO MISADJUSTMENT OF THE METER ZERO ADJUSTMENT SCREW OR USE OF AN INACCURATE MULTIMETER.

10. Rotate the Voltage Adjust Control fully counterclockwise and depress the 5-150 VDC Range Switch.

11. Connect a 2.5 k ohm, 25 watt resistor across the B+ output connectors.

    Depress the 150-300 VDC Range Switch and turn the Voltage Adjust Control clockwise until 250 DCV is read on the top red scale.

12. Depress the 0-100 mA Metering Switch and turn the Voltage Adjust Control clockwise until 100 mA is read on the black milliamp (mA) scale.

    The High Voltage Power Supply will current limit at slightly more than 100 mA. The Overload Indicator light flashes and the output voltage drops to zero if output current exceeds 100 mA. The High Voltage Supply may be reset by turning the supply off for one second.

13. Rotate the Voltage Adjust Control fully counterclockwise and disconnect the multimeter leads.

DC VOLTAGE (0-50 VDC)

1. Adjust a multimeter to measure safely negative (—) DC at 50 volts.

2. Connect the multimeter test leads to the C— output terminals, observing proper polarity.

3. Depress the 0-50 VDC Metering Switch, and rotate the Bias Adjust Control to read exactly 50 volts on the power supply Output Meter.

4. The multimeter should read to within 3% of 50 volts (48.5 — 51.5 volts).

5. Rotate the Bias Adjust Control fully counterclockwise and disconnect the multimeter test leads.

AC VOLTAGE (12.6 VAC)

1. Adjust a multimeter to measure safely 12.6 volts AC.

2. With the power supply on, there should be approximately 12.6 volts AC between the 12.6/6.3 VAC binding posts (Items 16 and 17) under full 2 ampere load.

3. Short the 12.6/6.3 VAC binding posts together. After a few seconds, one or both of the circuit breakers will "pop" out. Notice that the output voltage has dropped to zero.

4. Wait approximately 30 seconds and then depress one or both of the circuit breakers and release. Note that 12.6 volts AC is again available.

AC VOLTAGE (6.3 VAC)

1. Measure 6.3 volts AC between the left 12.6/6.3 VAC binding post (Item 17) and the common binding post (Item 18) under full load.

2. Short these two jacks together. After a few seconds the left circuit breaker will "pop" out (Item 19). Notice that the output voltage has dropped to zero.

3. After about 30 seconds depress the circuit breaker and release. Note that 6.3 volts AC is again available.

4. Repeat steps 1, 2, and 3 in a similar way for the right 12.6/6.3 VAC binding post (Item 16).

GENERAL

A series of practical applications is presented in this section to aid in further familiarizing the user with the High Voltage Power Supply. These exercises will simulate typical situations which may confront the user, and illustrate instances in which current calculations are performed in order to use the instrument properly.

USING THE 12.6 VAC OUTPUT

1. Using Figure 2-1 and the space provided, draw a circuit showing two 6.3 VAC lamps, at 1.3 A each, connected to the 12.6 VAC binding posts.

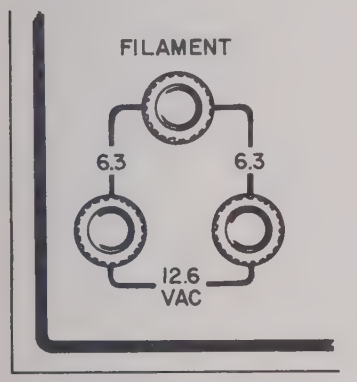

FIGURE 2-1

2. Will the circuit breakers hold for the circuit of Figure 2-1? ___ _____

3. If the current rating of each lamp in Figure 2-1 were doubled, would the circuit breakers hold? _____

4. Using Figure 2-2 and the space provided, draw a circuit showing two 12.6 VAC lamps, at 750 mA each, connected to the 12.6 VAC binding posts.

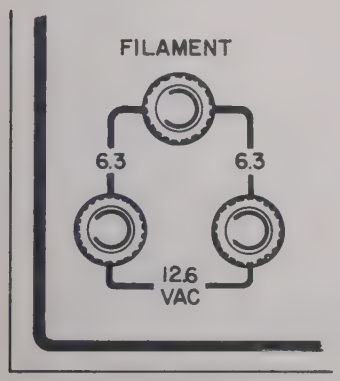

FIGURE 2-2

5. Will the circuit breakers hold for the circuit of Figure 2-2? _____

6. If the current rating of each lamp in the circuit of Figure 2-2 were increased to 950 mA each, would the circuit breakers hold? _____

USING THE 6.3 VAC OUTPUT

1. Using Figure 2-3 and the space provided, draw a circuit showing four 6.3 VAC lamps, at 750 mA each, connected to the 6.3 VAC output voltage.

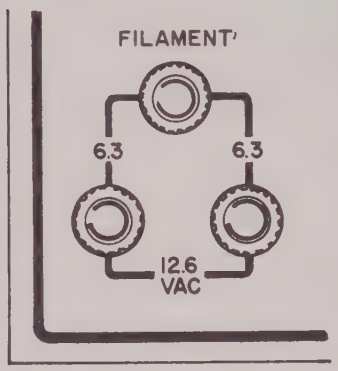

FIGURE 2-3

2. Will the circuit breakers hold for the circuit of Figure 2-3? _____

3. If the current rating of each lamp in the circuit of Figure 2-3 were increased by 300 mA, would the circuit breakers hold? _____

4. If, for example, the circuit breakers did not hold, how long must you wait before they may be reset? _____

USING THE 5 to +300 VDC OUTPUT

1. With the circuit connected as shown in Figure 2-4, calculate the total current drawn with S1 and S2 open, I_t = _____ mA.

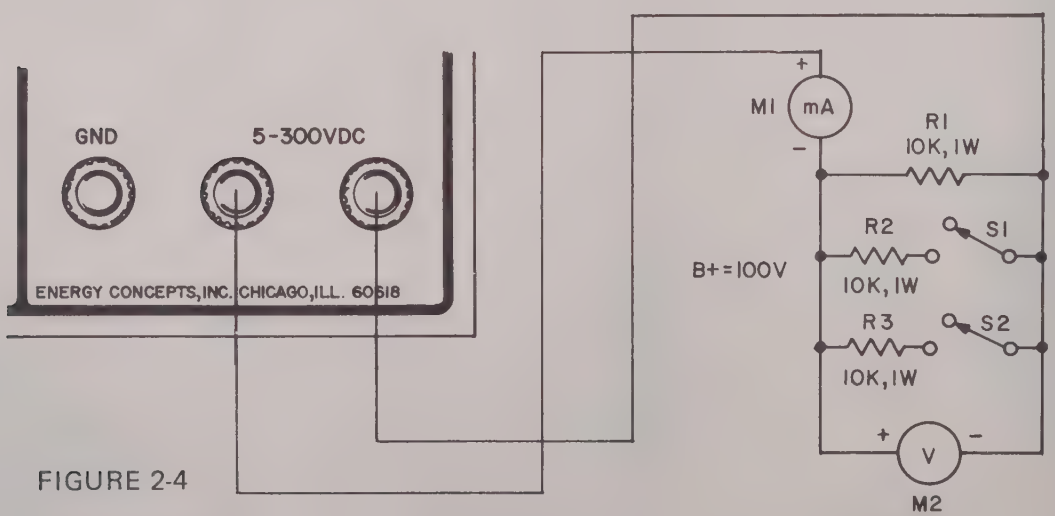

FIGURE 2-4

2. What value of current will ammeter M1 measure when switch S1 is closed? Assume that S2 is open. _____ mA.

3. Will the circuit shut down and go into an overload condition when this amount of current is drawn? _____

4. What would happen if resistor R1 were to become shorted?

5. When switch S2 is closed, and S1 open, what value of current will ammeter M1 read? _____

USING THE 0 to −50 VDC BIAS OUTPUT

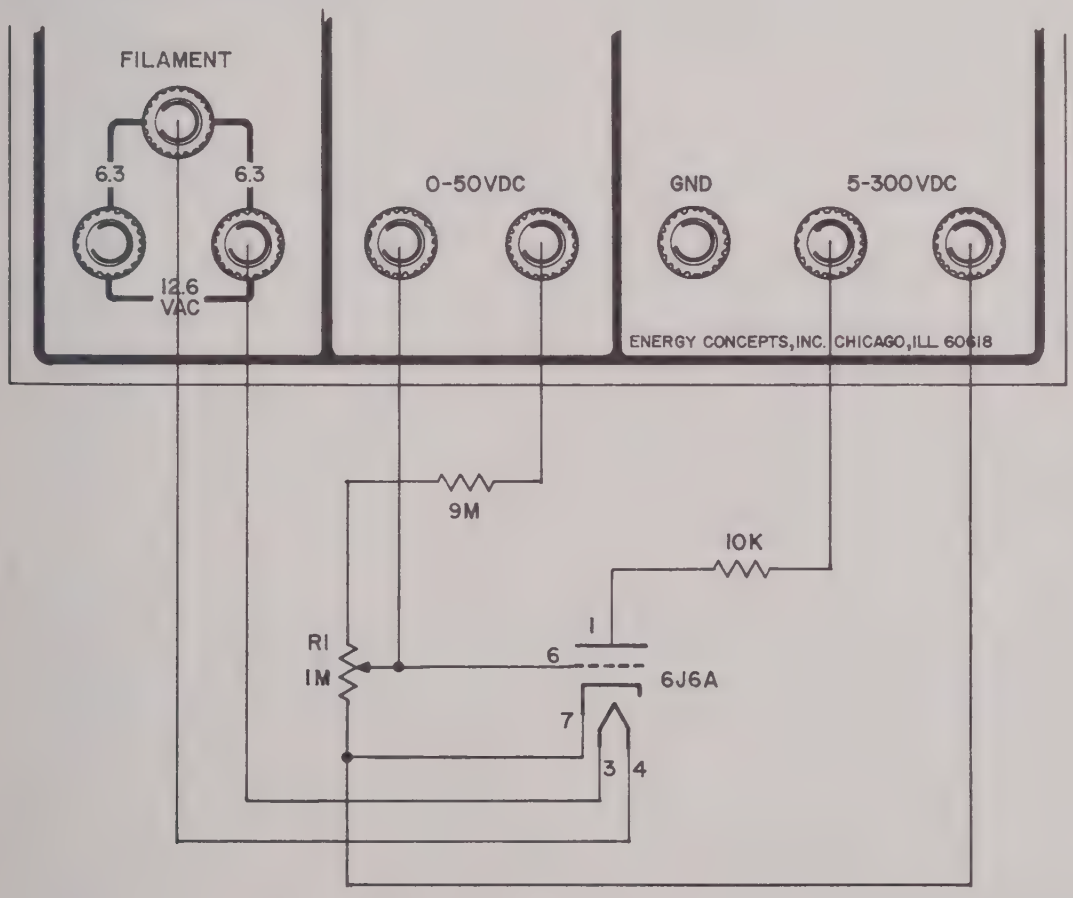

FIGURE 2-5

1. Figure 2-5 shows how the power supply can supply all the voltages needed for a circuit simultaneously. If the unit is set for a 0-50 VDC output and the pointer indicates a midscale reading on the Output Meter, what is the voltage at the C− terminal with respect to circuit ground? _____

2. If R1 is at the center of rotation, what is the grid voltage? _____

3. If a grid bias of −1.5 volts were desired, what would be the proper output voltage for the C− supply? _____

MAINTENANCE INFORMATION

SECTION 3

GENERAL

The Energy Concepts High Voltage Power Supply is a precision instrument which, when used and maintained properly, will provide years of trouble-free operation. However, when service is required, the chassis parts and circuit board components are easily accessible and clearly identified for convenience in troubleshooting.

NOTE: ALL TROUBLESHOOTING, COMPONENT REPLACEMENT, AND ALIGNMENT OF THIS INSTRUMENT SHOULD BE PERFORMED BY AUTHORIZED SERVICE PERSONNEL ONLY.

CASE REMOVAL

1. Disconnect the AC power cable from the AC source, and remove all leads from the front panel.
2. Using a 9/64" Allen wrench, remove the four Allen-head cap screws from the end caps. The Allen-head cap screws are identified in Figure 1-1 by the box-enclosed letters A, B, C, and D.
3. Lay the end caps to one side, and remove the two 8-32 x 5/16" binder-head screws from beneath the case.
4. Slowly slide the chassis forward out of the case. It may be necessary to tilt the front panel up slightly in order to clear the case front.

INTERNAL FUSE

The High Voltage Power Supply is equipped with an internal line protection fuse. This fuse, located on the circuit board, is a 1.5 A fast-blow type which protects the unit in the event of transformer failure or severe line voltage variations.

CIRCUIT DESCRIPTION

High Voltage Supply

The basic circuit is shown in Figure 3-1. A DTS 801 series-pass transistor, Q5, is controlled by a comparison amplifier, IC1. The negative side of the comparison amplifier's low voltage supply is floated at a fixed voltage (approximately 7 V) away from the positive output lead of the high voltage. One half of this fixed voltage is used as a reference for one input of the differential comparison amplifier. This scheme of floating the comparison amplifier power supply and deriving the reference for the comparison amplifier ensures that the comparison amplifier inputs are between the plus and minus voltage supplied to it, regardless of what the high voltage output is.

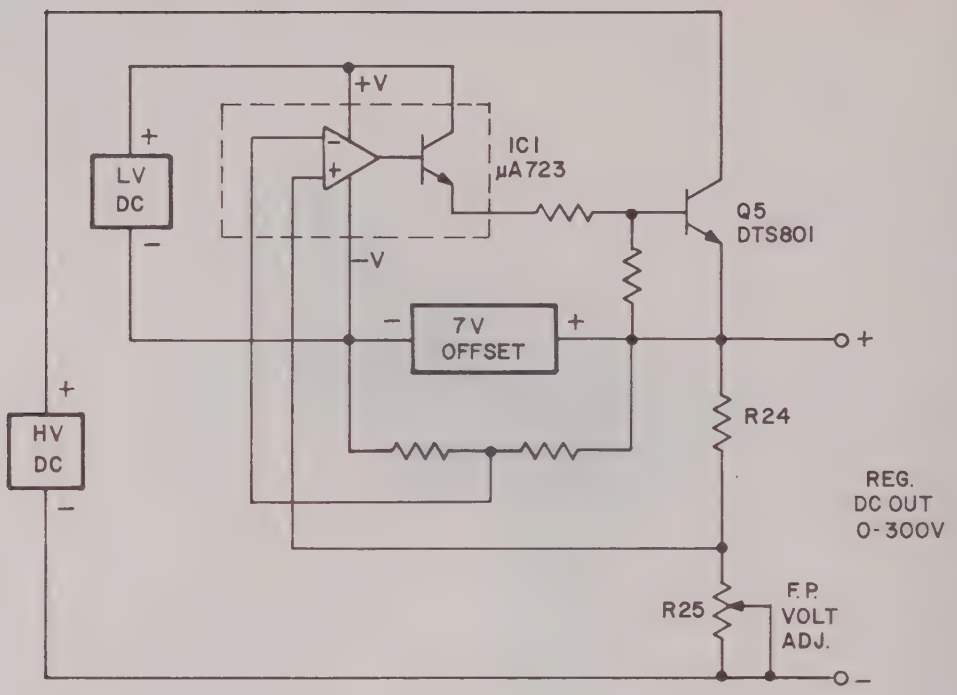

FIGURE 3-1

A fraction of the voltage between the positive and negative high voltage output terminals supplies the other input to the comparison amplifier. The closed loop consisting of the comparison amplifier and the series-pass control transistor, Q5, causes the two inputs to the comparison amplifier to be equal. Any inequality is amplified and causes the series-pass transistor (Q5) to change the output voltage in a direction to bring the difference toward zero. Thus, the plus input to the comparison amplifier is maintained at a fixed voltage below (negative) the positive high voltage output terminal. This fixed voltage is a fraction of the high voltage determined by the ratio of R24 and R25. By varying R25, the output voltage varies to maintain the constant voltage across R24. R25 is the front panel Voltage Adjust Control.

Detailed Circuit Description

Reference is made to the full schematic diagram. The 115 V AC, 60 Hz input enters through a fuse and the front panel on-off switch, S1. The line voltage is applied to the primary of the transformer with the pilot light (front panel) across the primary.

High Voltage Power Supply

The High Voltage Power supply circuit is shown on the upper part of the schematic. Two independent secondary windings, with bridge rectifiers and capacitor filters, are used to power these circuits. The upper winding is tapped to supply main power for the high voltage output on two ranges, 5 to 150 V and 150 to 300 V. The lower winding supplies power for operation of the internal reference and regulator circuits. It is floated at a fixed voltage away from the positive high voltage output terminals.

The negative side of the unregulated high voltage is common with the negative high voltage output terminal. The positive side of the unregulated high voltage is applied, through a reverse voltage blocking diode, D17, to the collector of series-pass control transistor, Q5. The emitter of Q5 is the positive output of the regulated high voltage supply. A 10 ohm series resistor has been inserted in the emitter circuit of Q5 as a current sensor for an automatic overload shutdown circuit.

The current overload shutdown circuit senses the voltage drop across the 10 ohm resistor through an adjustable set point potentiometer, R22. When the voltage on the arm of this potentiometer reaches the firing point of the C106A SCR, Q8, the SCR fires and conducts current through the series diode, D18, and terminal 13 of the 723 regulator circuit, IC 1. This pulls the base of the 723 output transistor negative toward the potential of the high voltage positive output terminal. This tends to shut off the 723 output transistor and consequently the DTS 801. Once triggered, the SCR remains conducting and the high voltage pass transistor, Q5, remains cut off until power is turned off. Triggering of the SCR also turns on the NE555 timer, IC 2, by supplying IC 2 with power by the voltage drop across the 2.7 k resistor, R29, between the SCR anode and the positive low voltage supply. The timer circuit is a low frequency oscillator, which flashes the front panel LED overload indicator.

The 723 regulator and DTS 801 series-pass transistor function as described in Figure 3-1. The fixed offset voltage between the positive output terminal and the negative side of the Low Voltage Power Supply is derived from the internal reference of the 723. This is a stable internal reference brought out to terminal 6, and is a nominal 7 volts. Due to limited loading allowed on this circuit, this voltage is used to drive a follower type circuit, consisting of Q6, Q7, and R16, which maintains the voltage between the positive output terminal and the negative of the low voltage supply. The resistive divider consisting of two 8.2 k resistors, R17 and R18, provides the tie point for the reference input to the comparison amplifier, as previously described.

Range switching between 5 to 150 V and 150 to 300 V is done by ganged switches S2 and S3. The transformer tap is switched so that only the unregulated voltage needed is supplied on the 150 V range, reducing the power dissipation in the DTS 801, Q5. Since in this way the DTS 801 effectively operates only over a 150 V range, whether in the 0 to 150 or 150 to 300 V range, its maximum dissipation is the same for a given current regardless of which range it is on.

The other section of the Range Switch, S3, inserts a resistance in series with the front panel Voltage Adjustment potentiometer. Since the regulating circuit maintains a constant voltage at the junction of R26 and R27, inserting a resistor in series with R25 forces the output to be high even when R25 is reduced to zero. The minimum output voltage on the high range is established by the ratio of R24 to R26 plus R27, and the maximum is established by the ratio of R24 to R25 plus R26 plus R27.

Protection against reverse voltage or AC applied to the output terminal is provided by a high current reverse diode MR 754, D19, across the output terminals. This diode will draw sufficient current from the external source to blow a 15 amp fuse or circuit breaker without damage to the power supply. The diode D17, in series with the DTS 801 Q5, is for blocking positive overvoltage on the output terminals and preventing destructive reverse current through the DTS 801. The four series diodes, D20 through D23, across the DTS 801 base to emitter and the two 1N914 diodes, D25 plus D26, in the sensing circuit to the comparison circuit input are all protecting diodes to prevent damage from the short overload prior to opening the external fuse or circuit breaker.

Bias Supply

The basic circuit of the bias supply is shown in Figure 3-2. The voltage to the negative output terminal is controlled by a D40N2 series-pass transistor, Q3. The series-pass transistor is controlled by the output of a differential transistor pair, Q1 and Q2, which compares a fixed voltage with a fraction of the voltage between the output terminals. The base of Q1 of the differential pair is tied to the positive output terminal of the bias supply. The common-emitter resistor of the Q1, Q2 pair is two junction voltages (base-to-emitter plus one diode) more positive than the Q1 base. The Q2 base is therefore one junction voltage (approximately 0.6 V) more positive than the positive bias output terminal. The closed loop causes the voltage at the base of Q2 to be maintained at this voltage. Any change in this voltage due to input or load changes causes an error, which is amplified and causes the series-pass transistor to correct the output in a direction

to bring the right side base voltage back to this fixed 0.6 volt. Varying R5 changes the fraction of the output voltage applied to the base of the differential pair, causing the output voltage to change so that the voltage at the bottom of R5 is maintained constant. Thus R5 serves as the front panel Bias Adjust Voltage Control.

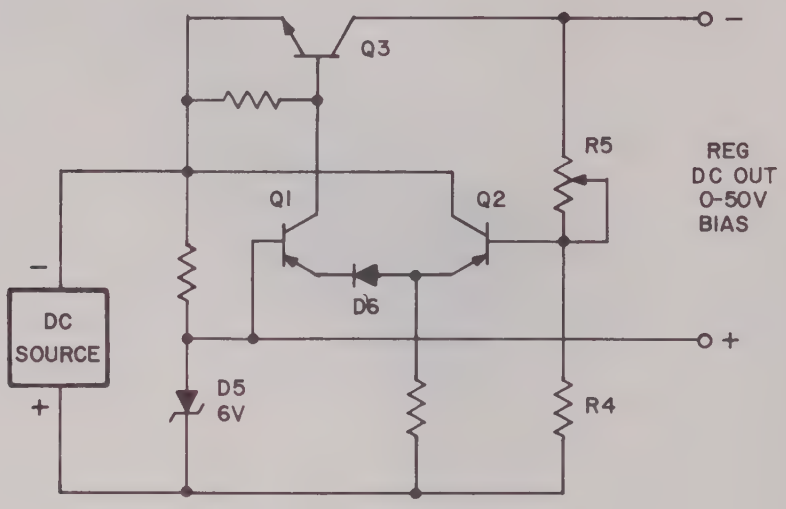

FIGURE 3-2

The plus side of the DC supply, the differential pair emitter circuit, and the output sampling divider are all referenced to a fixed voltage (approximately 6 V) more positive than the positive bias output terminal. This allows control of the output down to zero volts while still maintaining operating voltages across the control circuits.

Unregulated power is provided by a separate secondary winding, bridge rectifier, and filter capacitor. Current limiting is provided by resistor R2 + R3 in series with the series-pass transistor, Q3, and the MPS 6514, Q4, transistor. When the current through resistor R2 + R3 is sufficient to overcome the MPS 6514 base-emitter drop (0.6 V), the MPS 6514 conducts and its collector pulls the base of the D40N2 negative, turning it off. Protection against AC and reverse voltage applied to the output is provided by a MR 754 diode, D8, as in the high voltage supply, plus the addition of a series blocking diode, D7.

Filament Supply

This is merely a separate secondary winding on the power transformer. It is a 12.6 V center-tapped winding to provide series or parallel output for 6.3 or 12.6 V. Each side is protected by a 2 amp resettable circuit breaker.

Metering

A switchable front panel meter is provided for monitoring the bias output voltage, high voltage output, and high voltage output current. The pushbutton switches are interlocked to select one of the ranges 0 to 100 mA, 0 to 300 V, and 0 to 50 V. The meter has separate scales corresponding to these ranges.

CIRCUIT BOARD COMPONENT IDENTIFICATION

The circuit board component mounting configuration is shown in Figure 3-3. In this illustration the components are shown from the top side of the board, and are identified by actual part and location.

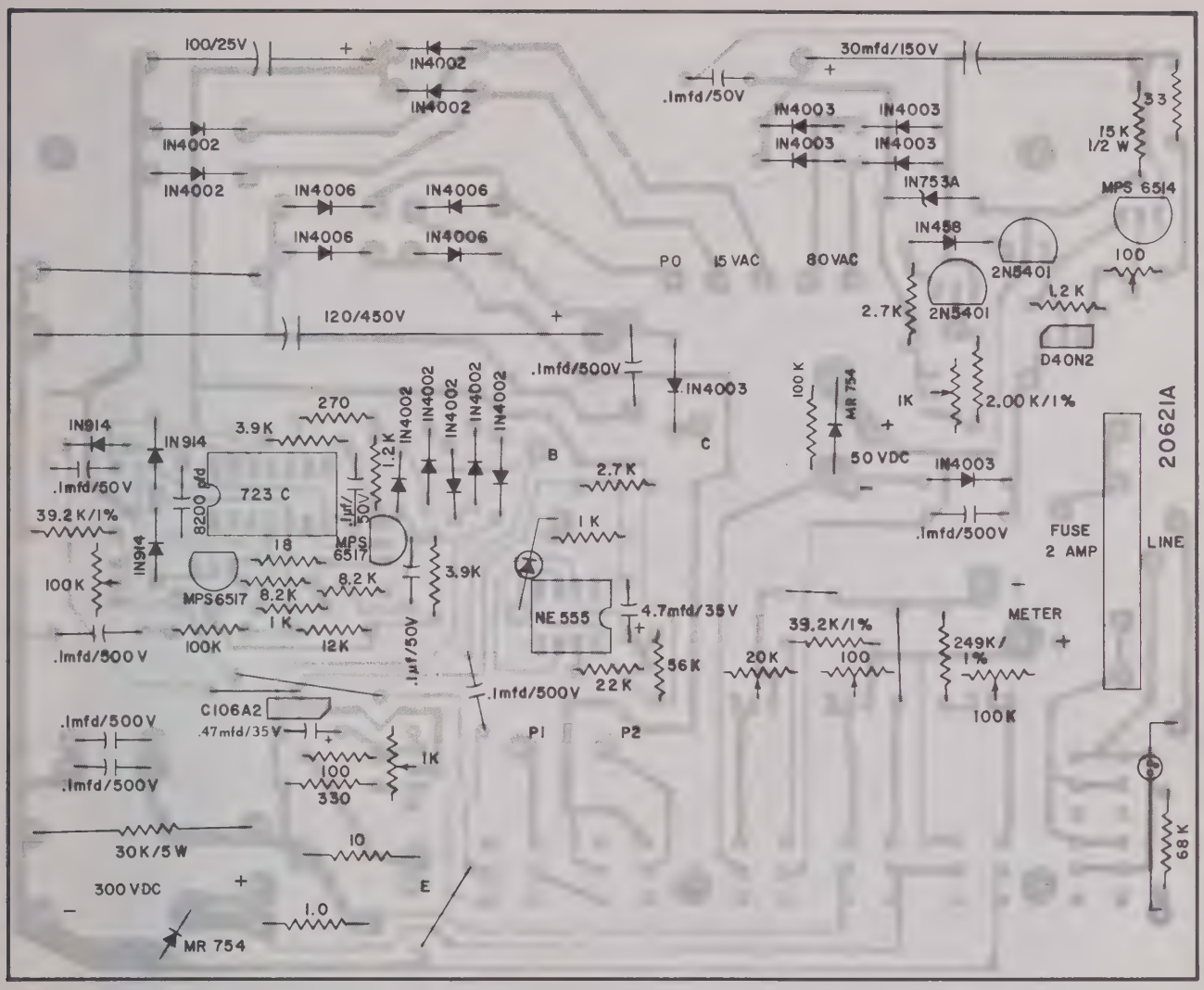

FIGURE 3-3

CALIBRATION PROCEDURE

Calibration should be done with the case off and the printed circuit board unfastened and lying beside the instrument on an insulating surface. Refer to Figure 3-4 when making calibration adjustments.

1. Plug the unit into a 0-135 V variable transformer (variac) set to zero. Turn the front panel Bias Control fully clockwise. Push 0-50 V Meter Switch to monitor the 50 V supply. Simultaneously monitor the 50 V output with an external calibrated meter.

2. Turn the power supply on and slowly increase the variac. The meters should begin to indicate some output at an AC input of about 20 V. Continue to increase the variac output to about 50 V, watching that the power supply output continues to rise.

3. Push the 0-300 V Meter Switch. Turn the front panel High Voltage Control fully clockwise. Push the

5-150 V and 150-300 V range switches. The meter should give some indication on both ranges with 50 to 75 V input from the variac. Continue to increase the variac output to see that the high voltage output continues to increase.

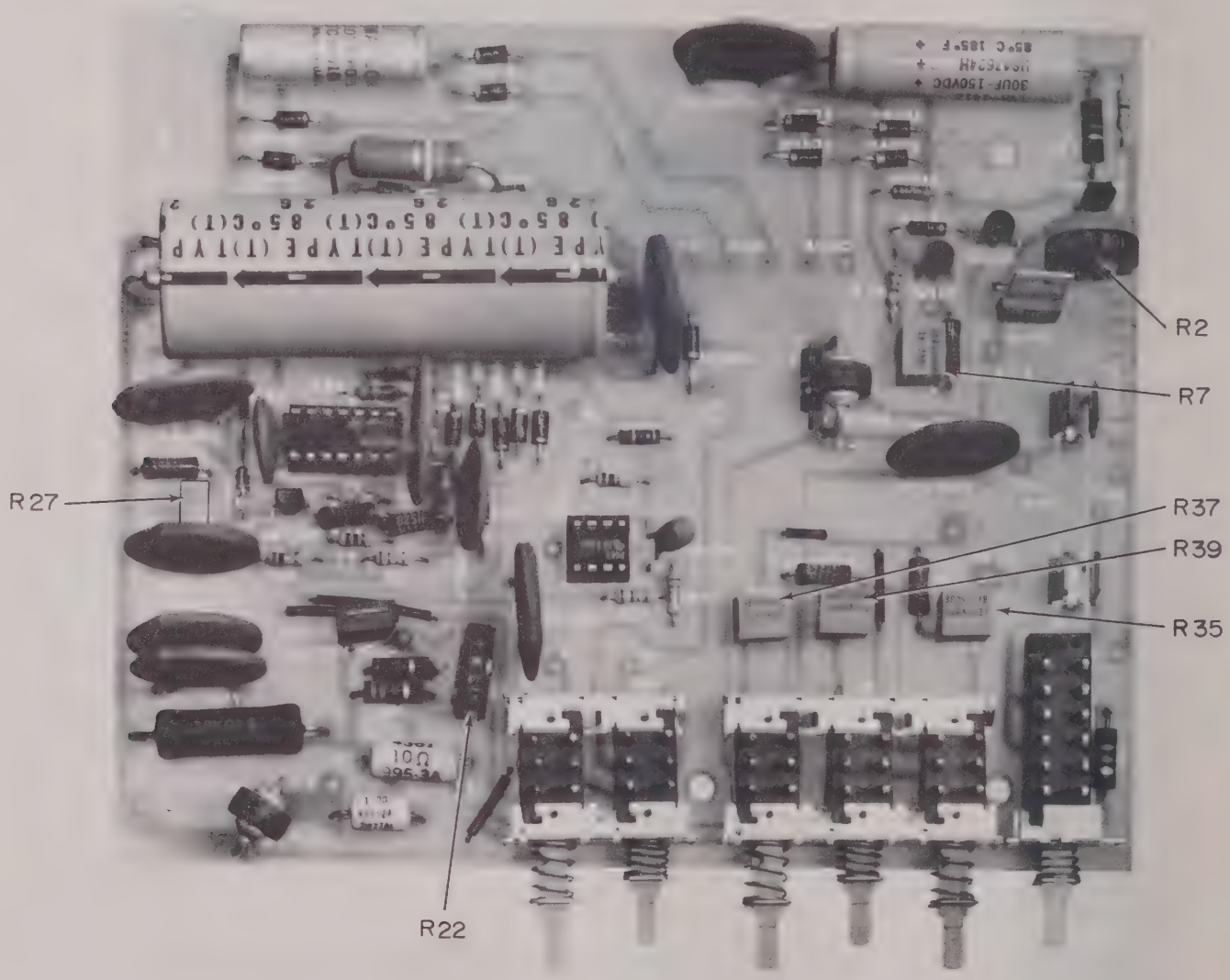

FIGURE 3-4

4. Increase the variac output to 110 to 120 V. With the 0-300 V Meter Switch depressed, push the 150-300 V Range Switch. Connect an external calibrated meter to the high voltage output terminals. Adjust R27, the 100 k potentiometer (Output Voltage Adjust), so that the external calibrated meter reads 305 to 310 V. NOTE: The front panel High Voltage Control is still fully clockwise.

5. Adjust the front panel Voltage Adjust Control so that the calibrated meter reads 300 V. Adjust R35, the 100 k potentiometer behind the switches, until the front panel meter reads 300 V.

6. Push the 5-150 V Range Switch. The meter should read more than 150 V but less than 180 V.

7. Switch to the 150-300 V range. Turn R22, the 1 k potentiometer, fully clockwise. Use a calibrated external milliammeter in series with a 3000 ohm, 50 W, load resistor connected across the high voltage output terminals. Adjust the high voltage to obtain 50 to 100 mA through the calibrated meter. Adjust R39, the 100 ohm potentiometer behind the switches, so the front panel meter reads the same as the calibrated meter.

8. Open the load circuit on the high voltage output (by means of a switch or by disconnecting one lead of the external meter). Set the front panel meter to read 300 V. Close the load circuit (3000 ohms) and observe the front panel meter. The reading with load or without load should be the same within 1-1/2 volts (this is essentially unreadable as a meter deflection). If a better measure of regulation is desired, use a three- or four-digit digital meter on the high voltage output terminals. Caution: 30 watts is being dissipated and the load resistor will get hot.

9. Connect the 3000 ohm load and leave the high voltage set at 300 V. Vary the input voltage down to 105 volts AC and then up to 125 volts AC. The high voltage should remain constant within 1-1/2 volts. Return the variac to about 115 V AC output.

10. With the high voltage supply at 300 V and the 3000 ohm load attached, add a 10 k ohm, 10 W, load in parallel with the 3000 ohms. Adjust R22 slowly until the overload light comes on. The voltage should drop to near zero. Remove the 10 k load, turn power supply off for several seconds, then turn power back on. The overload light should be out and the indicated voltage should return to 300 V.

11. Set front panel Bias Control fully clockwise and set bias current limit potentiometer, R2, the 100 ohm potentiometer behind the fuse, fully clockwise.

12. Push Meter Switch to the 0-50 V range. Monitor the output voltage across the bias terminals with a calibrated voltmeter. Adjust R7, the 1 k potentiometer, until the calibrated meter reads about 52 to 55 volts.

13. Adjust the front panel Bias Control until the calibrated meter reads 50 V. Adjust R37, the 20 k resistor behind the switches, until the front panel meter reads 50 V.

14. Attach a 10 k ohm load across the bias output terminals with the Bias Control set to give 50 volts at the output. Adjust R2, the 100 ohm potentiometer, until the bias voltage drops to about 40 volts. Remove the 10 k ohm load resistor. The meter should return to 50 V.

15. Attach a 47 k to 50 k ohm load resistor across the bias output terminals. Observe the meters to see that the output voltage does not vary more than 1% (0.5 V) between loaded and unloaded.

16. With the 47 k to 50 k ohm resistor still attached, vary the input AC voltage from 105 V AC to 125 V AC. The bias voltage should not vary more than 1% (0.5 V). Return variac output to approximately 115 V.

17. With an AC meter, measure the voltage at the filament terminals for the voltages shown on the panel. With no load on these outputs, the voltage will read about 7 V from center tap to each side and about 14 V across the end terminals.

18. Turn unit off and pull the line plug from the socket. Discharge the 120 μF, 450 V capacitor, C5, *(with caution)* by placing the 10 k resistor across it. Install unit in the case. Plug the unit into an AC outlet, turn on, and recheck bias and high voltage meter readings and controls as a final check that no damage was done closing the unit.

TROUBLESHOOTING SUGGESTIONS

The primary aid to troubleshooting is an understanding of the circuit operation as described in earlier sections. With that understanding, systematic checking for typical voltages will allow diagnosing most problems. Typical voltages are shown on the schematic.

In checking the voltages shown, a number of precautions should be taken. First, all outputs are floating relative to each other, so care must be exercised in choosing a reference point. Generally, voltages in the bias circuit should be made relative to the *positive* output terminal (which is shown on the schematic). In the high voltage section, voltages should be measured relative to the *negative* output terminal with an important exception: Since the low voltage supply floats a fixed voltage from the *positive* output, measurements must be made from either the positive output or from the negative side of the floating supply. For clarity and easiest analysis, it is recommended that voltages in that part of the circuit be measured relative to the *negative* of the *low voltage* supply. Voltages so measured are marked with an asterisk on the schematic.

ANSWERS TO PRACTICAL APPLICATIONS

USING THE 12.6 VAC OUTPUT

1. Using Figure 2-1 and the space provided, draw a circuit showing two 6.3 VAC lamps, at 1.3 A each, connected to the 12.6 VAC binding posts.

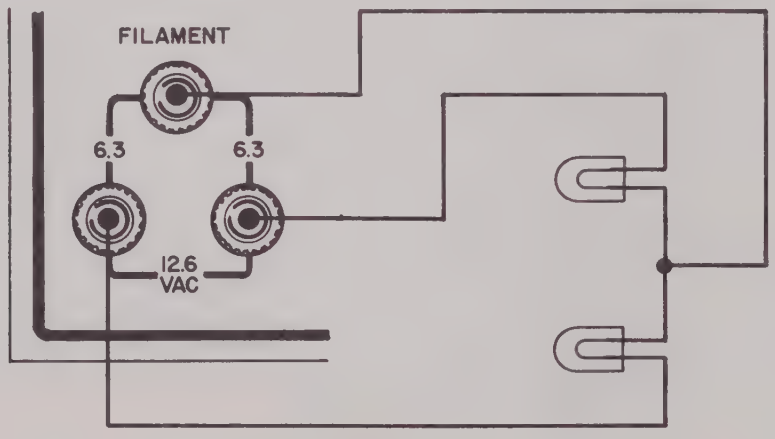

FIGURE 2-1

2. Will the circuit breakers hold for the circuit of Figure 2-1? *Yes*

3. If the current rating of each lamp in Figure 2-1 were doubled, would the circuit breakers hold? *No*

4. Using Figure 2-2 and the space provided, draw a circuit showing two 12.6 VAC lamps, at 750 mA each, connected to the 12.6 VAC binding posts.

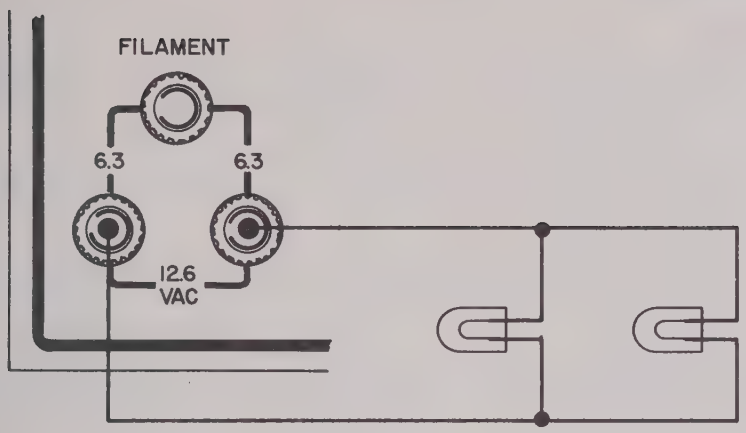

FIGURE 2-2

5. Will the circuit breakers hold for the circuit of Figure 2-2? *Yes*

6. If the current rating of each lamp in the circuit of Figure 2-2 were increased to 950 mA each, would the circuit breakers hold? *Yes*

USING THE 6.3 VAC OUTPUT

1. Using Figure 2-3 and the space provided, draw a circuit showing four 6.3 VAC lamps, at 750 mA each, connected to the 6.3 VAC output voltage.

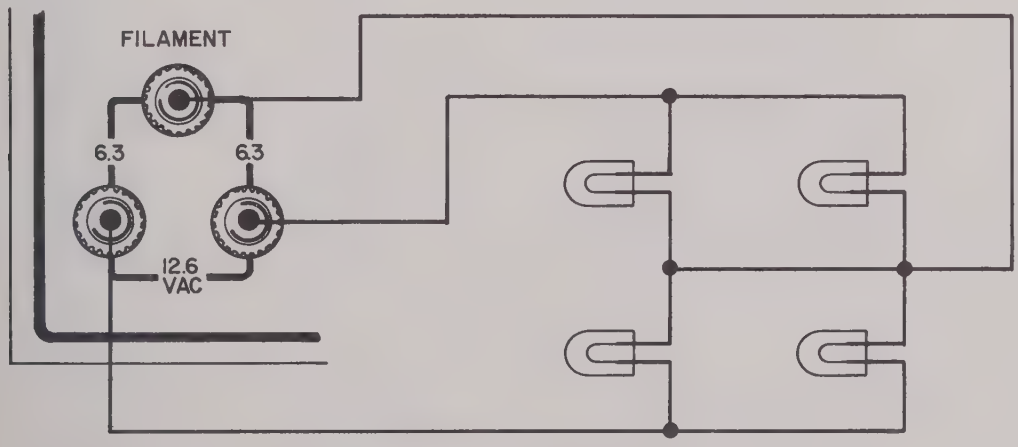

FIGURE 2-3

2. Will the circuit breakers hold for the circuit of Figure 2-3? *Yes*

3. If the current rating of each lamp in the circuit of Figure 2-3 were increased by 300 mA, would the circuit breakers hold? *No*

4. If, for example, the circuit breakers did not hold, how long must you wait before they may be reset? *Approximately 30 seconds*

USING THE 5 to +300 VDC OUTPUT

1. With the circuit connected as shown in Figure 2-4, calculate the total current drawn with S1 and S2 open, I_t = *10* mA.

2. What value of current will ammeter M1 measure when switch S1 is closed? Assume that S2 is open. *20* mA.

3. Will the circuit shut down and go into an overload condition when this amount of current is drawn? *No*

4. What would happen if resistor R1 were to become shorted? *Circuit would shut down and go into overload condition.*

5. When switch S2 is closed, and S1 open, what value of current will ammeter M1 read? *20* mA

USING THE 0 to −50 VDC BIAS OUTPUT

1. Figure 2-5 shows how the power supply can supply all the voltages needed for a circuit simultaneously. If the unit is set for a 0-50 VDC output and the pointer indicates a midscale reading on the Output Meter, what is the voltage at the C− terminal with respect to circuit ground? *−25 V*

2. If P1 is at the center of rotation, what is the grid voltage? *−2.5 V*

3. If a grid bias of −1.5 volts were desired, what would be the proper output voltage for the C− supply? *−30 V*

SERVICE PARTS LIST

SCHEMATIC REFERENCE NUMBER	PART NUMBER	COMPONENT DESCRIPTION
PC BOARD PARTS		
		SEMICONDUCTORS
Q6, Q7	20624	MPS 6517 Transistor
Q4	20625	MPS 6514 Transistor
Q1, Q2	20626	2N5401 Transistor
Q3	39506	D40N2 Transistor
Q8	35089	C106A2 SCR
IC1	30015	723C IC
IC2	20409	NE555 IC
		DIODES
D13, D14, D15, D16	15236	1N4006
D1, D2, D3, D4, D7, D17	15650	1N4003
D9, D10, D11, D12, D20, D21, D22, D23, D24	20108	1N4002
D6	20622	1N457
D8, D19	20428	MR754
D5	20623	1N753A Zener Diode
D18, D25, D26	21035	1N914
		POTENTIOMETERS
R7	20633	1K Ohm, Cermet Trimpot
R39	39530	100 Ohm, Carbon Trimpot
R2	20634	100 Ohm, Cermet Trimpot
R27, R35	20635	100K Ohm, Cermet Trimpot
R37	20636	20K Ohm, Cermet Trimpot
R22	32141	1K Ohm, Carbon Trimpot
		RESISTORS
R33	20639	1 Ohm, 2-1/4W, 5%
R20	20640	10 Ohm, 3-1/4W, 5%
R34	20641	249K Ohm, 1/2W, 1%
R26, R36	20642	39.2K Ohm, 1/2W, 1%
R8	20643	2K Ohm, 1/2W, 1%
R17, R18	20644	8.2K Ohm, 1/2W, 1%
R1	35304	15K Ohm, 1W, 5%
R12, R30	20645	1K Ohm, 1/4W, 5%
R13	20646	12K Ohm, 1/4W, 5%
R9	15271	100K Ohm, 1/2W, 10%
R31	20647	22K Ohm, 1/4W, 5%
R32	20648	56K Ohm, 1/4W, 5%

R28	20649	30K Ohm, 5W, 1%
R16	20650	18 Ohm, 1/4W, 5%
R4, R15	20651	1.2K Ohm, 1/4W, 5%
R3	20652	33 Ohm, 1/4W, 5%
R10	35140	180K Ohm, 1W, 10%
R6, R29	20653	2.7K Ohm, 1/4W, 5%
R14	20654	270 Ohm, 1/4W, 5%
R19	20655	3.9K Ohm, 1/4W, 5%
R21	20656	100 Ohm, 1/4W, 5%
R23	15266	330 Ohm, 1/2W, 5%
R11	20658	100K Ohm, 1/4W, 5%
R24	20659	2.2K Ohm, 1/4W, 5%
R38	20660	10 Ohm, 1/4W, 5%
R40	33120	68K Ohm, 1/2W, 10%

CAPACITORS

C5	20627	80-150 μF, 450 VDC Axial
C1	20628	30 μF, 150 VDC Axial
C3	39021	100 μF, 25 VDC Axial
C14	20629	4.7 μF, 35 VDC Tantalum
C13	20630	0.47 μF, 35 VDC Tantalum
C2, C6, C10, C11, C12, C15, C16	20631	0.1 μF, 500 VDC Disc
C4, C7, C9	30057	0.1 μF, 50 VDC Disc
C8	20632	8200 pF, 1000 VDC Disc

MISCELLANEOUS

	20621	PC Board
S1	20705	DPDT Pushbutton Switch
S5, S6, S7	20805	4PDT Pushbutton Switch
S8, S9	20904	2-Station, 2-Pole Pushbutton Switch
	22025	Fuse Holder
	15146	1.5A Fast-Blow Fuse

CHASSIS PARTS

SEMICONDUCTOR

Q5	39507	DTS 801 Transistor

POTENTIOMETERS

R25	20637	100K Ohm, 1W
R5	20638	25K Ohm, 1W

MISCELLANEOUS

LED	21640	LED MV5054-1
NE-2	22026	NE-2 Pilot Light

	20661	Chassis
	20608	Front Panel
CB1, CB2	20926	Circuit Breaker
M1	20619	Meter, 0-1 mA
	20621	Power Transformer
	21027	Heat Sink Bushing, Teflon
	29020	Line Cord
	16113	Binding Post, Black
	16112	Binding Post, Red
	16115	Binding Post, Yellow
	16114	Binding Post, Green
	16117	Binding Post, Blue
	21033A	Heat Sink
	21027	Heat Sink Spacer
	21031	Strain Relief
	40511	Button, Red
	40510	Button, Blue
	40508	Gray Knob
	20662	Phenolic Spacer, Threaded 6-32 x 1/4"
	20663	Aluminum Spacer, Threaded 6-32 x 1/4"
	40513	Switch Spacer 0.093
	10523	8-32 x 3/8" BHMS
	797	No. 8 Lockwasher
	982	8-32 x 5/16" Nut
	11268	6-32 x 1/2" BHMS
	735	No. 6 x 0.281 Lockwasher
	1190	6-32 x 1/4" Nut
	709	6-32 x 1/4" BHMS
	10823	6-32 x 3/8" BHMS
	10776	No. 6 x 1/4" Fiber Washer
	16238	Extrusion, Plastic 3.9"
	20612	Cover, Back
	20613	Cover, Bottom
	16220	Cover, Top Vent Holes
	20665	Connector Plug
	20666	Receptacle
	20667	Connector Plug
	20668	Male Pin Terminal
	20669	Female Pin Terminal
	20670	Receptacle
	20644	Identification Plate
	15160	3-Terminal Solder Lug
	16230	End Caps
	16239	8-32 x 1" Allen Head Cap Screw
	16237	Rubber Feet

WARRANTY

ENERGY CONCEPTS INCORPORATED warrants this equipment to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of this unit which under normal installation, use, and service discloses such defect, provided that the unit is delivered by the purchaser to the dealer from whom purchased, or to Energy Concepts Incorporated, or to a stipulated agent, intact, for the purpose of examination within a period of two years from the date of sale to the original purchaser and provided such examination discloses in our judgment that it is defective.

This warranty does not apply if the equipment has been subjected to misuse, neglect, improper installation, used in violation of instructions provided by us, or if repaired or in any way altered outside of our factory or authorized service facility, or if the serial number has been removed, defaced or changed.

Any part approved for remedy or exchange hereunder will be remedied or exchanged without charge to the owner.

Energy Concepts, Inc., assumes no liability for injury, damage, or expense claimed to have been incurred through the use or in the installation of our equipment and products.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of this equipment.

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3956 W. Belmont Avenue
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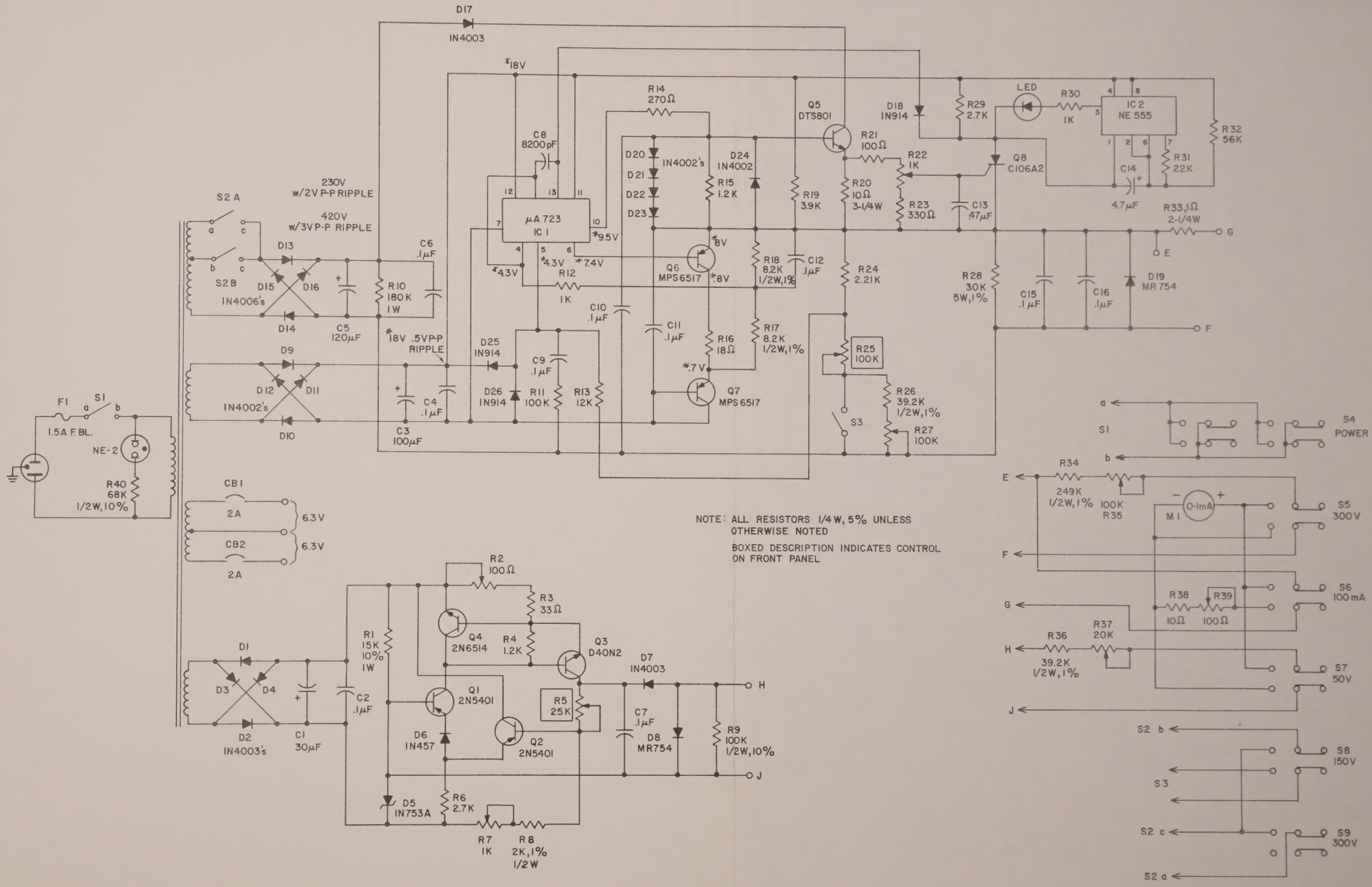
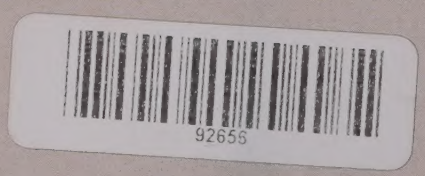

D17
IN4003
*18V
R14
270Ω
C8
8200pF
D20
D21
D22
D23
IN4002's
D24
IN4002
Q5
DTS801
D18
IN914
R29
2.7K
LED
R30
1K
IC 2
NE 555
R32
56K
R31
22K
C14
4.7μF
Q8
C106A2
R21
100Ω
R22
1K
R20
10Ω
3-1/4W
R23
330Ω
C13
.47μF
R19
3.9K
R15
1.2K
μA 723
IC 1
*9.5V
*8V
Q6
MPS6517
R18
8.2K
1/2W,1%
C12
.1μF
R24
2.21K
R33,1Ω
2-1/4W
G
E
R28
30K
5W,1%
C15
.1μF
C16
.1μF
D19
MR754
F
230V
w/2V P-P RIPPLE
420V
w/3V P-P RIPPLE
S2 A
S2 B
D13
D15
D16
IN4006's
D14
C6
.1μF
R10
180K
1W
C5
120μF
*4.3V
R12
1K
*7.4V
*4.3V
C10
.1μF
C11
.1μF
R16
18Ω
R17
8.2K
1/2W,1%
*7V
Q7
MPS6517
*18V .5VP-P
RIPPLE
D25
IN914
D26
IN914
C9
.1μF
R11
100K
R13
12K
D9
D12
D11
IN4002's
D10
C4
.1μF
C3
100μF
R25
100K
S3
R26
39.2K
1/2W,1%
R27
100K
F1
1.5A F.BL.
S1
a
b
NE-2
R40
68K
1/2W,10%
CB1
2A
6.3V
CB2
2A
6.3V
NOTE: ALL RESISTORS 1/4W, 5% UNLESS
OTHERWISE NOTED
BOXED DESCRIPTION INDICATES CONTROL
ON FRONT PANEL
R2
100Ω
R3
33Ω
Q4
2N6514
R4
1.2K
Q3
D40N2
D7
IN4003
H
R1
15K
10%
1W
D1
D3
D4
C2
.1μF
Q1
2N5401
R5
25K
C7
.1μF
D8
MR754
R9
100K
1/2W,10%
J
D6
IN457
Q2
2N5401
D2
IN4003's
C1
30μF
D5
IN753A
R6
2.7K
R7
1K
R8
2K,1%
1/2W
S4
POWER
S1
a
b
R34
249K
1/2W,1%
100K
R35
E
F
M1
0-1mA
S5
300V
G
H
R38
10Ω
R39
100Ω
S6
100mA
R36
39.2K
1/2W,1%
R37
20K
J
S7
50V
S2 b
S8
150V
S3
S2 c
S9
300V
S2 a

SCHEMATIC



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